

Response of NiMH Cells to Burp Charging

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Introduction

Performance cycling and calorimetric analysis of nickel metal hydride (NiMH) cells have revealed that reverse pulse ("burp") charging improves performance over other charging techniques. Burp charging periodically applies a short-duration, high-rate discharge pulse followed by short rest during an otherwise galvanostatic charge as shown in Fig. 1. Results show improved charge input and output, lower heat generation during charge, lower charge overvoltage, and no loss of cycle life [1].

The burp charge method has been improved over the years purely by trial and error. Several hypotheses have been put forward (see articles cited in [1]) to explain why burp charging improves performance. For example, it has been suggested that the discharge pulses dislodge gas bubbles that would otherwise mask the active electrode surfaces. However, no evidence was found in the literature to support this or other hypotheses. Overall, a better understanding of the phenomenon is needed to help guide further improvements in the burp-charging method, and this is the objective of our investigation.

Experimental Procedure

Three charge current waveforms were compared in this study: galvanostatic, burp, and pause. The pause waveform was identical to the burp except that the discharge pulses were replaced with rests. The charge methods were compared during charge/discharge cycling tests with a video-microscope and with a manometer.

The surface of the nickel electrode during charge was examined with a 70X magnification microscope. This was done by extracting the electrode coil from a commercial 2.4 Ah cell and immersing or partially immersing it in 6.4M KOH electrolyte solution.

For the manometric experiments, a small hole was drilled in the top and bottom of each cell can and connected to the ends of a U-tube containing water.

Results and Discussion

In-situ video-microscopy showed that significant amounts of gas evolve as a result of applying charge current. This results in undesirable side reactions to the main electrochemical charge reactions. Bubble generation at electrode surfaces was found to increase non-linearly with increasing state-of-charge. However, no cause-and-effect relationship between the occurrence of a pause step or a "burp" pulse in current and the release of bubbles could be established visually. Nevertheless, a reduction in the flow of bubbles was detected soon after the transition from charge to discharge. This indicated that gas is consumed at the onset of discharge. Note that if the discharge pulses caused gas dislodgment, one would expect the opposite, an increase in gas at the onset of discharge.

In-situ manometry showed that burp and pause

charge methods both generated significantly less gas than the galvanostatic charge method (see Fig. 2) while operating at equivalent charge input rates and using a cell with its electrolyte quantity unchanged. When cells were flooded with 6.4M electrolyte, all the methods produced more gas at earlier states of charge because exposed metal hydride was no longer present to catalyze gas consumption reactions. With flooded cells, pause charging loses its advantage over the galvanostatic method (see Fig 3) and burp charging has the lowest gas generation rate. Of the three methods, burp charging is the only one capable of consuming electrode surface gas by reversing the gas-generating electrochemical reactions during the discharge "burp" pulse.

Reference

1. E.C. Darcy, Ph.D Dissertation, University of Houston, Houston, TX (1998).

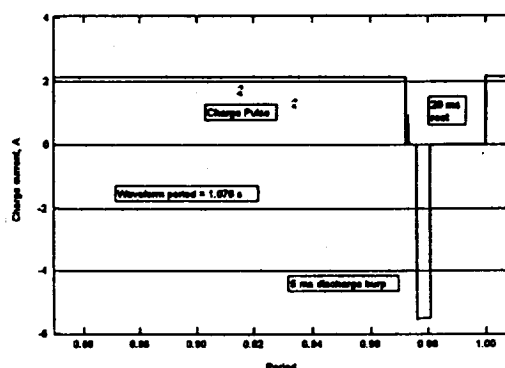


Fig. 1. Typical reverse pulse (burp) current waveform.

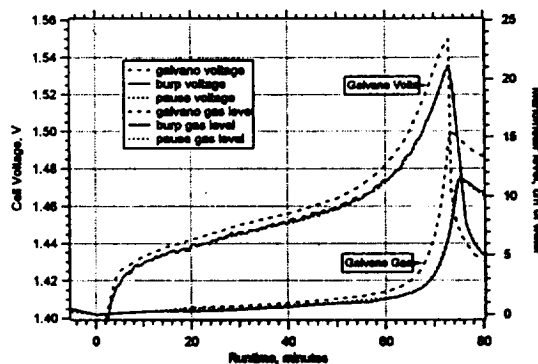


Fig. 2. Comparison of the charge overvoltage and gas generation of 3 charge methods versus run time.

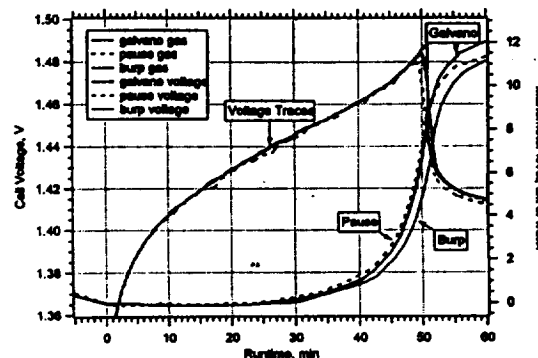


Fig. 3. Cell gas and voltage level during charging of a flooded NiMH cell.